

Claims

- [c1] A method of forming a plate for the passage through a set of apertures of at least one substance from a first side to a second side comprising the steps of:
forming a plurality of vertical apertures in a first ceramic greensheet;
forming a plurality of horizontal apertures in a second ceramic greensheet;
forming a plurality of vertical apertures in a third ceramic greensheet, in which at least some of said horizontal apertures in said second greensheet connect an aperture in said first greensheet with an aperture in said third greensheet;
filling at least some of said apertures with a filler material containing a temporary material and a matrix material;
laminating said first, second and third ceramic greensheets together;
sintering said first, second and third greensheets at a sintering temperature, thereby forming said plate containing said filler material filling passages therein;
and removing said temporary material, thereby creating a set of passages through said matrix.

- [c2] A method according to claim 1, in which:
said step of removing said temporary material is effected by heating said plate above said sintering temperature to a removal temperature such that said temporary material escapes into the ambient.
- [c3] A method according to claim 2, in which:
said temporary material is a material that sublimes at said removal temperature.
- [c4] A method according to claim 3, in which:
said temporary material is selected from the group comprising metals such as molybdenum, cooper and nickel.
- [c5] A method according to claim 2, in which:
said step of removing said temporary material is effected by heating said plate above said sintering temperature to a removal temperature above a melting point of said temporary material.
- [c6] A method according to claim 5, in which:
said temporary material is selected from the group comprising copper, silver, nickel.
- [c7] A method according to claim 1, in which:
said step of removing said temporary material is effected by dissolving said temporary material in a solvent.

- [c8] A method according to claim 1, in which:
apertures in at least one of said first, second and third greensheets are filled with a fugitive material that escapes into the ambient during said step of sintering.
- [c9] A method according to claim 2, in which:
apertures in at least one of said first, second and third greensheets are filled with a fugitive material that escapes into the ambient during said step of sintering.
- [c10] A method according to claim 5, in which:
apertures in at least one of said first, second and third greensheets are filled with a fugitive material that escapes into the ambient during said step of sintering.
- [c11] A method according to claim 7, in which:
apertures in at least one of said first, second and third greensheets are filled with a fugitive material that escapes into the ambient during said step of sintering.
- [c12] A method of forming a plate for the passage through a set of apertures of at least one substance from a first side to a second side comprising the steps of:
forming a plurality of vertical apertures in a first ceramic greensheet;
forming a plurality of horizontal apertures in a second ceramic greensheet;

forming a plurality of vertical apertures in a third ceramic greensheet, in which at least some of said horizontal apertures in said second greensheet connect an aperture in said first greensheet with an aperture in said third greensheet;

filling a first set of apertures with a fugitive material;

filling a second set of apertures with a composite material comprising a matrix material and a filler material;

laminating said first, second and third ceramic greensheets together;

sintering said first, second and third greensheets at a temperature such that said fugitive material escapes into the ambient;

and removing said filler material.

- [c13] A method according to claim 12, in which:
said step of removing said temporary material is effected by heating said plate above said sintering temperature to a removal temperature such that said temporary material escapes into the ambient.
- [c14] A method according to claim 13, in which:
said temporary material is a material that sublimes at said removal temperature.
- [c15] A method according to claim 14, in which:
said temporary material is selected from the group com-

prising molybdenum, copper and nickel.

- [c16] A method according to claim 12, in which:
said step of removing said temporary material is effected
by heating said plate above said sintering temperature to
a removal temperature above a melting point of said
temporary material.
- [c17] A method according to claim 16, in which:
said temporary material is selected from the group com-
prising copper, silver, nickel.
- [c18] A method according to claim 12, in which:
said step of removing said temporary material is effected
by dissolving said temporary material in a solvent.
- [c19] A method of forming a plate for the passage through a
set of apertures of at least one substance from a first
side to a second side comprising the steps of:
forming an array of apertures by a photolithographic
process in at least one template plate;
forming a first ceramic greensheet disposed on said
template plate;
transferring said array of apertures from said template
plate to said first ceramic greensheet to form a first array
of passages in said first ceramic greensheet;
forming a second array of passages through a second

ceramic greensheet connecting to said first array of passages;

laminating said first and second ceramic greensheets together;

sintering said first and second greensheets at a sintering temperature, thereby forming a plate containing passages therein extending from a first side to said second side opposite said first side.

[c20] A method according to claim 19, further comprising:
filling at least one set of passages with a temporary material before said step of laminating;
and removing said temporary material.

[c21] A method according to claim 20, further comprising filling a set of apertures with a composite material comprising a durable matrix material that forms a porous matrix during said sintering step and a temporary material, whereby said porous matrix permits passage of a reagent in operation.

[c22] A method according to claim 19, further comprising:
forming a second template plate containing a second array of apertures;
forming said second array of passages in said second ceramic greensheet connecting to said first array of passages by transferring said second array of apertures to

said second ceramic greensheet.

- [c23] A method according to claim 22, further comprising:
forming at least one intermediate ceramic greensheet
disposed between said first and second ceramic green-
sheets and containing a set of intermediate horizontal
passages connecting passages in said first and second
ceramic greensheets.
- [c24] A method according to claim 23, further comprising fill-
ing a set of apertures in one of said first, second and in-
termediate greensheets with a composite material com-
prising a durable matrix material that forms a porous
matrix during said sintering step and a temporary mate-
rial, whereby said porous matrix permits passage of a
reagent in operation.
- [c25] A method according to claim 22, in which said step of
removing said temporary material is effected by heating
said plate above said sintering temperature to a removal
temperature such that said temporary material escapes
into the ambient.
- [c26] A method according to claim 25, in which:
said temporary material is a material that sublimes at
said removal temperature.
- [c27] A method according to claim 23, in which:

said temporary material is selected from the group comprising molybdenum, copper and nickel.

- [c28] A method according to claim 23, in which:
said step of removing said temporary material is effected by heating said plate above said sintering temperature to a removal temperature above a melting point of said temporary material.
- [c29] A method according to claim 28, in which:
said temporary material is selected from the group comprising copper, silver, nickel.
- [c30] A plate comprising a set of apertures for the passage of at least one substance from a first side to a second side comprising:
a plurality of vertical apertures in a first ceramic sintered greensheet;
a plurality of horizontal apertures in a second ceramic sintered greensheet;
a plurality of vertical apertures in a third ceramic sintered greensheet, in which at least some of said horizontal apertures in said second sintered greensheet connect an aperture in said first sintered greensheet with an aperture in said third sintered greensheet;
and at least one supporting plate abutting one of said first and third ceramic sintered greensheets and having a

pattern of said apertures defined therein, whereby said apertures may be transferred accurately from said supporting plate to said one of said first and third sintered ceramic greensheets.

- [c31] A plate according to claim 30, in which:
said plate comprises two supporting plates abutting both said first and said third sintered greensheets.
- [c32] A plate according to claim 30, in which:
said plate comprises a supporting plate abutting first sintered greensheet.
- [c33] A plate according to claim 30, in which:
said plate comprises a supporting plate abutting said third sintered greensheet.
- [c34] A plate according to claim 30, in which:
said plate further comprises at least one intermediate plate abutting one of said first and said third sintered greensheets and comprising an edge frame and a structural component disposed within said edge frame.
- [c35] A plate according to claim 34, in which:
said plate further comprises at least one intermediate plate abutting said first sintered greensheet and comprising an edge frame and a structural component disposed within said edge frame.

[c36] A plate according to claim 30, in which:
said plate further comprises at least one intermediate
plate abutting said third sintered greensheet and com-
prising an edge frame and a structural component dis-
posed within said edge frame.